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IMPLICATIONS OF CONSTRUCTION OF A FLOOD CONTROL PROJECT UPON BALD EAGLE NESTING ACTIVITY

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Florida is regarded as the most important breeding area for southern Bald Eagles (*Haliaeetus leucocephalus leucocephalus*) (Sprunt 1954, Sprunt et al. 1973, Robertson 1978). Some of the densest breeding concentrations historically occurred along the now heavily urbanized middle Gulf and Atlantic coasts of the peninsula (Robertson 1978). These coastal populations are now greatly depleted or extirpated. Statewide, populations have decreased by at least 50% during the past 30 years (Robertson 1978).

Fifty-four percent of the statewide eagle production between 1972 and 1975 occurred in central Florida (Nesbitt et al. 1976). The Kissimmee Basin area in the grazing and lake country in the interior of this region (Fig. 1) has traditionally supported an important breeding population (Sprunt 1954, Howell and Heinzman 1967). Although that portion of the population associated with the Kissimmee Basin was regarded as stable as recently as the mid-1960's (Howell and Heinzman 1967), Heinzman and Heinzman (1970) reported a disturbing increase in nest desertions within the Lower Kissimmee Basin. This apparent decline in nest activity occurred during construction of a system of flood protection works in the Basin by the U.S. Army Corps of Engineers (Corps).

Nationwide, declines in certain Bald Eagle populations have continued in spite of reductions in chlorinated hydrocarbon pesticide use. Direct loss or deterioration of suitable habitat resulting indirectly from human activity may have replaced pesticide contamination as the major contributing factor in the decline of the southern Bald Eagle (Murphy and Coker 1978, Robertson 1978). Our study was initiated in an effort to ascertain the relationship between project construction and the status of Bald Eagles nesting in the Kissimmee Basin, and to provide a basis for assessment of the potential impact of system restoration on this endangered species.

STUDY AREA

That portion of the Kissimmee Basin in Osceola, Polk, Okeechobee, Highlands and Glades counties (Fig. 1) was selected for study. Orange and Lake counties were omitted because nesting data for the 1970's in these counties were incomplete.

The Kissimmee River drainage basin covers approximately 7700 km^2 in south-central Florida (Fig. 1). Waters rising near Orlando historically moved through a system of major lakes and associated creeks, marshes and sloughs to Lake Kissimmee (Montalbano et al. 1979a). From Lake Kissimmee, waters passed into the mile-wide floodplain and braided river channel

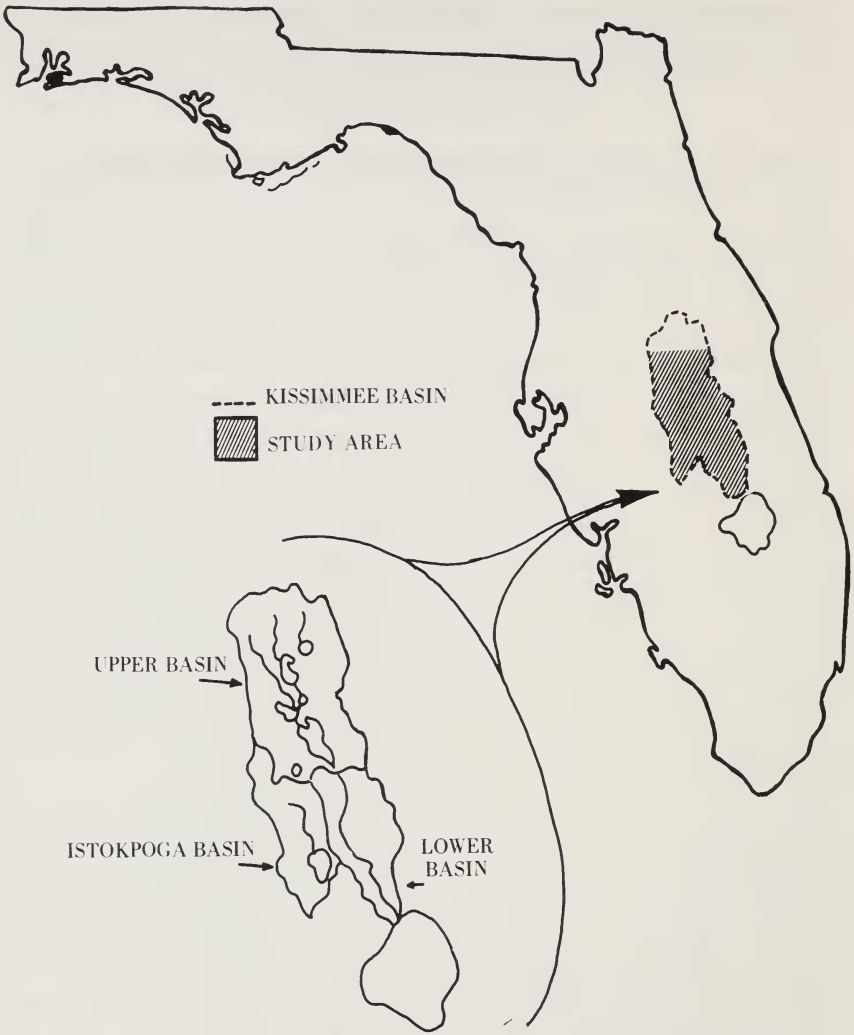

FIG. 1. The Kissimmee Basin, Florida, and location of the study area within this basin.

system of the Kissimmee River enroute to Lake Okeechobee (Florida Department of Administration 1975, Goodrick and Milleson 1974, Montalbano et al. 1979a).

Water level fluctuation was a key element in the productivity of the Kissimmee Basin, contributing to substrate improvement (Wegener and Williams 1974), development of diverse aquatic and wetland plant communities (Goodrick and Milleson 1974, Wegener and Williams 1974) and production and concentration of a high diversity of fish and wildlife food organisms (Burns 1976, Patrick 1978). The Corps completed construction of a flood control system in

the Basin during the 1960's (Florida Department of Administration 1975). This flood control system substantially altered and impaired ecosystem functions in the study area, as discussed below. For the purposes of this study, the Kissimmee River Basin is divided into segments.

Upper Basin.—The Upper Basin is that portion of the study area north of the general route of State Road 60 (Fig. 1). Approximately 13% of this 4100 km² area is covered by surface waters (Heaney et al. 1975), mostly large lakes with extensive littoral zone marshes. As a result of construction of the flood control project, canals between the major lakes of the Upper Basin were enlarged and lake levels were regulated by a system of water control structures completed in 1970 (U.S. Army Corps of Engineers 1979).

Water level stabilization in the Upper Basin reduced lake surface area, intensified agricultural land use and urban development, and resulted in degradation of existing habitat and loss of fishery resources of the area (Wegener and Williams 1975). Waterfowl inventories reported for the period November 1978–March 1979 by Montalbano et al. (1979b) indicated wintering waterfowl populations were approximately 25% below those reported for comparable areas during comparable survey periods between 1954 and 1957 (Florida Game and Fresh Water Fish Commission 1957).

Istokpoga Basin.—The 1700 km² Istokpoga Basin (Fig. 1) includes more than 40 lakes connected by natural streams, creeks, or canals. Lake Istokpoga, the principal lake in the Basin, characteristically fluctuated extensively. High lake stages and the magnitude of fluctuation were initially reduced by the construction of the Istokpoga Canal in 1949, and were further reduced through completion of the authorized flood control system for this portion of the Kissimmee Basin in 1962. Some form of water level management is in effect on most of the lakes in the Istokpoga Basin. High stages have been reduced through modification in outflow capacities, with resulting losses in fish and waterfowl habitats (Milleson 1976).

Lower Basin.—The Lower Basin comprises that portion of the Kissimmee Basin lying south of State Road 60, exclusive of the Istokpoga Basin (Fig. 1). The 1900 km² area (Heaney et al. 1975) includes the channelized Kissimmee River (C–38 Canal) and remnants of the original Kissimmee River and its tributaries.

The excavation of Canal C–38 and the construction of the system of five water control structures along the route of the Kissimmee River in the Lower Basin was completed in 1971 (Goodrick and Milleson 1974, Dineen et al. 1974). The 216-km braided river channel (Montalbano et al. 1979a) was bisected by a 127-km box-sided canal and system of water control structures (Dineen et al. 1974, Goodrick and Milleson 1974). Dredge spoil was deposited on floodplain marshes and in remnants of the braided river channel. Water levels which had fluctuated extensively prior to channelization were stabilized behind the five water control structures (Goodrick and Milleson 1974, Montalbano et al. 1979a). Canal design resulted in permanent drainage of the marshes immediately downstream from each water control structure, and permanent flooding of wetlands upstream from each structure.

MATERIALS AND METHODS

Information on the historical status (1959–1971) of Bald Eagle nesting territories in the Kissimmee River Basin was obtained from the field notes of the late George Heinzman. Heinzman compiled data received from mail surveys conducted in conjunction with the continental Bald Eagle project, and collected data personally on certain nests within the Florida Audubon Society sponsored Kissimmee Cooperative Bald Eagle Sanctuary.

Nesting records for 1972–1979 were obtained from aerial surveys conducted and summarized by D. Mager and T. Hines for the Florida Cooperative Bald Eagle Survey Committee. Flights were initiated in November each year to determine the onset of incubation. A second survey was flown in February to obtain production data. We mapped nesting territories and assigned the closest large body of water as a pair's feeding grounds. This designation was

considered appropriate since eagles tend to nest near bodies of water from which they obtain food (Robertson 1978). Status (active, inactive) of eagle nests within the Kissimmee Basin was determined following guidelines prepared by Postupalsky (1974). The number of active and inactive territories was determined on a yearly basis from 1959–1979 for the Upper Basin, the Istokpoga Basin and the Lower Basin. Data were grouped as "during" construction (1962–1970) and "post" construction (1977–1979). Records before 1962 were omitted, and only data for the 1977–78 and 1978–79 seasons could be used for post-construction analyses because of the insufficient coverage of many territories before 1962 and between 1971 and 1977.

Reproductive success (number of young per active territory, number of young per successful territory) was calculated from "post" construction records only because the aerial surveys flown following construction were considered more accurate in approximating actual eagle production than the ground surveys conducted by Heinzman.

RESULTS AND DISCUSSION

The status and production of Bald Eagle territories in the Upper Basin, the Istokpoga Basin, and the Lower Basin during (1962–1971) and after (1977–1979) construction of the flood control project are summarized in Tables 1 and 2. The Upper Basin contained a higher average annual number of active territories both during and after construction than either the Istokpoga Basin or the Lower Basin (Table 2). However, the Lower Basin annually averaged 12 active territories per 1000 km^2 during construction as compared to 8.1 active territories per 1000 km^2 in the Upper Basin and

TABLE 1

STATUS AND PRODUCTION OF BALD EAGLES NESTING WITHIN THE KISSIMMEE BASIN, FLORIDA, 1962–1971, 1977–1979

Status or production	Sub-basins of the Kissimmee River Basin					
	Upper Basin		Istokpoga Basin		Lower Basin	
	D[a]	P[b]	D	P	D	P
Total active territories	201	63	20	10	132	12
Total inactive territories	27	20	10	2	23	1
Number of pairs that raised:						
0 young	29	18	5	3	19	2
1 young	48	17	8	2	29	7
2 young	25	16	3	4	12	1
3 young	—	2	—	—	—	—
Number active but results unknown	99	10	4	1	72	2
Total territories	327	93	34	13	227	15
Total young produced	98	55	14	10	53	9

[a] During construction (1962–1971).
[b] Post construction (1977–1979).

TABLE 2

BALD EAGLE NESTING STATUS SUMMARY FOR SUB-BASINS OF THE KISSIMMEE BASIN DURING AND AFTER CONSTRUCTION OF THE FLOOD CONTROL PROJECT

	Upper Basin		Istokpoga Basin		Lower Basin	
Number territories	D[a]	P[b]	D	P	D	P
Active/year	33.3	36.5	2.7	5.5	22.7	6.0
Inactive/year	3.0	10.0	1.1	1.0	2.6	0.5
Total	36.3	46.5	3.8	6.5	25.3	6.5

[a] D = During construction (1962–1971).
[b] P = Post construction (1977–1979).

1.6 active territories per 1000 km^2 in the Istokpoga Basin. Following channelization of the Kissimmee River, annual nesting activity in the Lower Basin declined to 3.2 active territories per 1000 km^2 vs 8.9 active territories per 1000 km^2 in the Upper Basin, and 3.2 active territories per 1000 km^2 in the Istokpoga Basin. Documented nesting activity (active territories per year) increased in both the Upper and the Istokpoga basins following construction, and decreased by 74% in the Lower Basin during this same period (Table 2).

Table 3 compares post-channelization production of nesting eagles in the three sub-basins to the production of eagles statewide and in the Central Region (Nesbitt et al. 1976) during the 1977 and 1978 nesting seasons. The productivity of eagles nesting in the Kissimmee Basin during these years was similar to that of eagles elsewhere in the state. These data indicate that the reproductive performance of the reduced number of ea-

TABLE 3

PRODUCTIVITY TOTALS FOR THE STUDY AREA, THE CENTRAL FLORIDA REGION[a], AND STATEWIDE[b], 1977–1978 THROUGH 1978–1979

Area	Active territories[c]	Successful nests	Young produced	Young/ successful nest	Young/ active territory
Upper Basin	52	34	55	1.57	1.06
Istokpoga Basin	9	6	10	1.67	1.11
Lower Basin	10	8	9	1.13	0.90
Central Florida	366	210	310	1.51	0.87
Statewide	672	405	586	1.45	0.87

[a] Boundaries of Central Florida region are delineated in Nesbitt et al. 1976.
[b] File data, Florida Game and Fresh Water Fish Commission.
[c] Totals include only those territories for which nest success was determined.

gles nesting in the Lower Basin has not been impaired since channelization of the Kissimmee River. In general, construction of the flood control project did not appear to have affected Bald Eagles nesting in the Upper and Istokpoga basins on a long-term basis. The observed increase in nesting activity following channelization almost surely was an artifact of more intensive aerial coverage of these areas. However, an actual increase in breeding birds could also explain this occurrence. It is possible that birds displaced from traditional nesting territories in the Lower Basin or elsewhere relocated in the Upper and Istokpoga basins. The Upper Basin in particular has consistently supported a large population of eagles and has recently been recommended for designation as "essential habitat" by the Southern Bald Eagle Recovery Team.

In the 1964–65 nesting season, Heinzman (unpubl.) noted at least 21 active, seven inactive and only one territory of unknown status in the Lower Basin in his field notes. We consider this figure of 21 active territories a valid minimum estimate of the pre-channelization nesting eagle population in the Lower Basin, since Heinzman (1965) reported that the number of breeding pairs remained practically constant between 1959 and 1965. In the early 1930's, Howell recorded the location of 13 active territories in the Kissimmee Basin (Howell and Heinzman 1967). All sites were still occupied in the 1962–63 season, and 12 were occupied in 1964–65. By contrast, only six active territories were observed during the 1978–79 breeding season in this same area during the annual aerial Bald Eagle nesting survey. The results of our investigation suggest that, since channelization, the Lower Basin no longer supports its historic density of breeding eagles.

Elimination of suitable nest trees in the Lower Basin was not observed by Heinzman and Heinzman (1970), and we do not believe a shortage of suitable nest-sites exists. Although a cause-and-effect relationship can not be demonstrated, two factors implicate construction of the flood control project and subsequent deterioration in forage availability in the Lower Basin as a probable major factor contributing to the decline in Bald Eagle nesting activity. The first is the occurrence of earliest recorded increases in nest desertions in the Lower Basin concurrent with construction of the flood control project (Heinzman and Heinzman 1970). Secondly, the decline in Bald Eagle nesting in the Lower Basin relative to other study area segments is consistent with the relative degree of ecosystem disruption resulting from project construction in the three study area segments. The impact of channelization on natural wetland ecosystems was most severe in the Lower Basin, where 78% (16,443 ha) of the marsh area was drained (Pruitt and Gatewood 1976). This drainage obviously had a devastating effect on productivity and marsh faunal associations (Milleson 1976, Pat-

rick 1978). Channelization of the Kissimmee River resulted in declines in sport fish populations (Montalbano et al. 1979a, 1979b), probable declines in total fish populations (Florida Game and Fresh Water Fish Commission 1957), probable declines in fish species diversity, and a 93% reduction in wintering duck and American Coot (*Fulica americana*) populations from pre-channelization levels (Montalbano et al. 1979a, 1979b). In addition to actually reducing the quantity of eagle prey sources, channelization has also made remaining forage comparatively less available to eagles. Prior to channelization, water levels characteristically peaked in October, then fell rapidly until the onset of the May rainy season (Montalbano et al. 1979b). This precipitous drop in water levels concentrated fish and waterfowl during the eagle nesting season. As water evaporated from depressions, dead and dying fish were available in great abundance to foraging eagles.

It follows that restoration of the pre-channelization ecosystem in the Lower Basin could possibly reestablish the prey base and could contribute to reversal of recent trends in Bald Eagle nesting activity.

SUMMARY

We analyzed the status of southern Bald Eagle (*Haliaeetus leucocephalus leucocephalus*) nesting during and after construction of a flood control project in the Kissimmee River Basin in central Florida. A 74% decrease in the annual number of active territories was observed following construction of this flood control project in that segment of the study area where disruption of aquatic ecosystems and, therefore, a prey base for eagles, was most severe. Productivity of eagles nesting in all three sub-basins was comparable to that of eagles nesting in central Florida and statewide between 1977 and 1979.

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